THE JOURNAL

OF

BONE AND JOINT SURGERY

BRITISH VOLUME
Vol. 42–B, 1960

PUBLISHED IN LONDON BY MESSRS E. & S. LIVINGSTONE LTD.
AMERICAN VOLUME PUBLISHED AT 8 THE FENWAY, BOSTON, MASS.

AS7

ANCHORAGE OF THE FEMORAL HEAD PROSTHESIS TO THE SHAFT OF THE FEMUR

JOHN CHARNLEY, MANCHESTER, ENGLAND

From the Centre for Hip Surgery, Wrightington Hospital, near Wigan, Manchester Royal Infirmary and Park Hospital, Davyhulme

The factors which govern the loosening of the bond between a femoral head prosthesis and living bone are not by any means clearly understood; but it seems reasonable to suggest that a desirable feature of any design would be a large area of contact between the prosthesis and the bone, in order to distribute the load as widely as possible.

When the weight of the body is transmitted from a prosthesis to bone at no more than three or four points of relatively small area, local pressures may be so high that crushing of the bone may occur, and a prosthesis which was tight at the end of the operation may soon become loose after carrying the weight of the body. Slight movement between the prosthesis and living bone, repeated at every weight-bearing step, is probably responsible for progressive loosening and total failure of the fixation.

The attempt to extend the anchorage of femoral head prostheses by various forms of shaft fixation has been a fertile field for mechanical ingenuity, but all ordinary mechanical fixations cannot be " tailored " to fit the bone exactly; therefore the transmission of body weight to the bone will produce a number of " high-spots " of extreme pressure. A disadvantage of complexity in shaft fixation of a prosthesis is that, the more perfect its mechanical design, the more difficult it is to insert at operation. In the method to be described the shape of the shaft element of the prosthesis is not particularly important provided it has adequate strength and the fixation into the upper end of the femur is obtained by embedding the prosthesis in a suitable cement. A " cold-curing " acrylic cement has been found to be satisfactory for this purpose, the cement being made by mixing a powder and a fluid immediately before use. The fluid is self-sterilising and the powder can be sterilised by exposure to formalin vapour for some weeks.

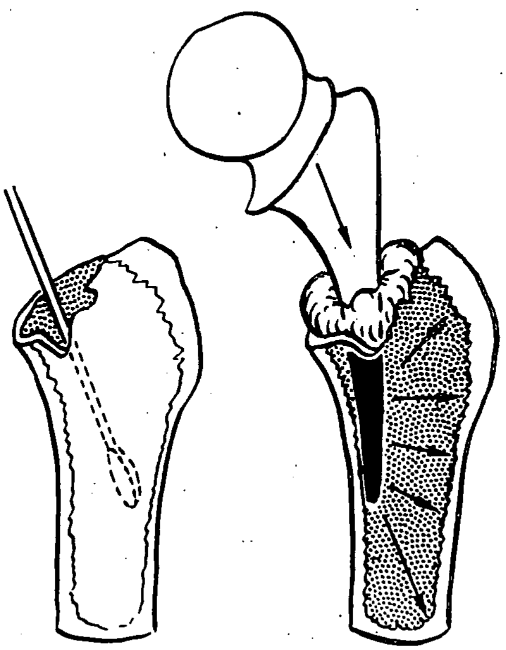

FIG. 1

Showing how insertion of the stem of the prosthesis expands the cement and drives it into intimate contact with the internal shape of the bone.

It is possible that an amine-cured ethoxyline resin, as reported by Bloch (1958) for bonding fractures, might be superior to acrylic cement for this purpose. The resin used by Bloch is alleged to have direct adhesion to bone and it is believed that bone will grow into it with the passage of time. In using acrylic cement in this application no attempt has been made to obtain direct adhesion between the surface of the cement and the bone. The plastic is used purely as a " filling " and functions as though it were part of the prosthesis; it is as though the stem of the prosthesis were cast in metal to the exact shape and size of the cavity of the upper end of the femur. The bonding of the prosthesis depends on dispersing the weight of the body over a large area of bone and providing the surface of contact with a rough and irregular texture.

After the hi
femoral neck is
canal for about
removed from tl
walls. It is not
there has been m
of spongy bone,
a cavity of consi
base of the head

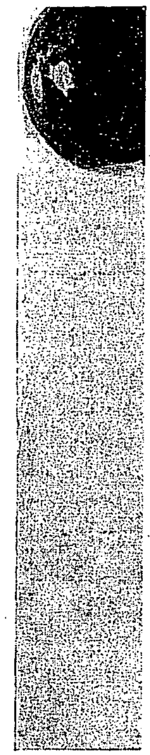

Figure 2—P
in contact w

The cold-cu
stiff dough is obt
of plastic from tl
in the gloved har
a sausage. The
dough is pushed
is now inserted i
the cut surface o
of the prosthesis
is expanded and
cast of the rough
markings on the
smooth surface
that mixing start

TECHNIQUE

After the hip joint has been exposed and the femoral head removed, the cavity of the femoral neck is curetted with a strong spoon reaching into the upper end of the medullary canal for about six inches. The curettage is pursued until all soft cancellous bone has been removed from the medullary canal, and especially from the medial, anterior and posterior walls. It is not necessary to curette deep into the interior of the greater trochanter. When there has been much disuse atrophy in elderly patients this procedure removes a large amount of spongy bone, which would have been mechanically unsound to hold a prosthesis, and leaves a cavity of considerable size. A suitable prosthesis is tried in position to make sure that the base of the head fits well on the cut surface of the femoral neck.

FIG. 2

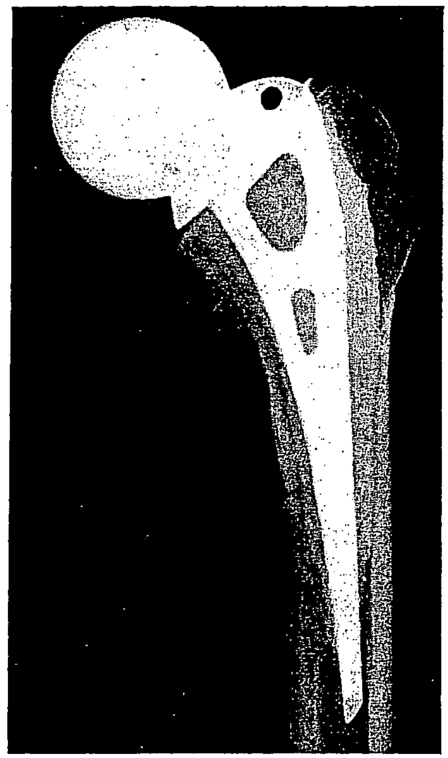

FIG. 3

Figure 2—Photograph by oblique illumination to reveal the large surface area of the plastic in contact with the bone. Figure 3—Radiograph showing prosthesis fixed by cement containing a radio-opaque filler.

The cold-curing cement is mixed by adding the liquid to the powder and mixing until a stiff dough is obtained. After mixing for three or four minutes the spatula will pull " hairs " of plastic from the surface of the dough. When this state has been reached the dough is lifted in the gloved hand (it shows no tendency to stick to rubber) and is moulded into the shape of a sausage. The cavity in the upper end of the femur is sucked clear of blood and the plastic dough is pushed deep into it and rammed into position as quickly as possible. The prosthesis is now inserted into the middle of the plastic mass and any excess will force itself out between the cut surface of the neck of the femur and the base of the femoral neck. As the narrow end of the prosthesis is followed by the progressively increasing diameter of the stem the dough is expanded and forced into every crevice in the interior of the femur (Fig. 1) until a perfect cast of the rough interior of the femur is produced. The total surface area of the trabecular markings on the surface of the plastic must be considerably greater than that of a similar smooth surface (Fig. 2). The process of setting takes about fifteen minutes from the time that mixing starts to the final hardening.

COMMENT

Although cold-curing acrylic cement is a hard substance when set, in this application the strength of the material is not the most important feature. If the metallic stem of the prosthesis is adequate for the stresses involved, the "grouting" in which the stem is embedded, as engineers call this use of cement, needs only to resist compression, and it would work well even if it were as brittle as plaster-of-Paris.

The process of "cold-curing" is an exothermic reaction, and in a large mass the temperature of the plastic can rise to boiling point; however, there is no danger to living tissues because the large mass of a metallic steel prosthesis absorbs much of the heat and prevents a dangerous rise of temperature.

The material is not visible in radiographs after operation, but can be made so by the addition of about 25 per cent by volume of dry barium sulphate to the powdered resin before it is mixed (Fig. 3).

It is now one year since the first six patients were operated upon by this method, and in the last nine months a further twenty-three patients have been similarly treated. No ill effects traceable to the plastic have been encountered, and the general quality of the results appears superior to that in cases in which the plastic anchorage had not been used.

I am indebted to Dr D. C. Smith, M.Sc., Ph.D., F.R.I.C., of the Turner Dental School, University of Manchester, for advice on the choice of plastic cement in this application and for experiments in rendering it radio-opaque.

Five years a
method of arthrc
research and exp
operated upon.
This paper r
seventeen patien
It is hoped t
case and a disc
fifteen years.

The indicati
of one knee, with
treatment of not
Most of the
osteoarthritis an

In assessing
the knee through
was classed as "
operations were
revisionary opera
was done the da
femoral stem. T
secondary revisic
In eight kne
up to the time o
the first prosthe
operation. In fi
remained good
In one knee (Cas
and again after re
failure a "fair"
first and second

Mechanical failu
the points where
the prosthesis at
forty months afte
would, after a fal
the knee and son